Research Product 86-25

User Interface Requirements for Battlefield Management Systems (BMS)

ARI Field Unit at Fort Knox, Kentucky

Training Research Laboratory

August 1986

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REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER ARI Research Product 86-25	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) USER INTERFACE REQUIREMENTS FOR BATTLEFIELD MANAGEMENT SYSTEMS (BMS)		5. TYPE OF REPORT & PERIOD COVERED Final Report June 1985-December 1985
		6. PERFORMING ORG. REPORT NUMBER --
7. AUTHOR(s) Carl W. Lickteig		8. CONTRACT OR GRANT NUMBER(s) --
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Research Institute for the Behavioral and Social Sciences, Fort Knox Field Unit Steele Hall, Fort Knox, KY 40121-5620		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 2Q162717A790 351 H1
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Research Institute for the Behavioral and Social Sciences 5001 Eisenhower Avenue, Alexandria, VA 22333-5600		12. REPORT DATE August 1986
		13. NUMBER OF PAGES 62
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) --		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE --

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

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18. SUPPLEMENTARY NOTES

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Command and Control	Human factors engineering	Map information
User requirement	Battlefield information	BMS
Armored vehicle SMI	Map use	Graphic portrayal

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This research investigated user interface requirements for operating the Battlefield Management System (BMS) and the system's potential for reducing the small unit leader's workload. BMS, the primary product improvement planned for the M1A1 Block II modification, is an integrated complex of battlefield information acquisition, processing, and communication technologies. While BMS is expected to significantly enhance command and control, it may require a substantial change in standard operating procedures, such as a shift from vocal (FM radio) to nonvocal communication, and from paper maps to (Continued)

ARI Research Product 86-25

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digital map displays. To ensure that user requirements were included in the design of this innovative system, a prototype interface was developed on an Integrated Raster Imaging System (IRIS) 1400 computer system. A cross-section of small unit leaders worked with a digitized terrain data base (Fulda Gap) and menu-structured report functions to construct and edit the map displays and tactical reports needed for their respective duty positions. User requirements for display features and control functions were obtained, together with their recommendations for overall configuration, size, and operating characteristics of the BMS interface. Keywords; Command and Control Systems; human factors Engineering; data displays.

Research Product 86-25

User Interface Requirements for Battlefield Management Systems (BMS)

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August 1986

Army Project Number
2Q162717A790

Human Performance Effectiveness
and Simulation

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FOREWORD

To ensure that the U.S. Army's future weapon systems are useable by our soldiers, the Army Research Institute for the Behavioral and Social Sciences (ARI) performs behavioral research to provide guidelines and specifications for matching equipment designs with soldier capabilities and limitations. Within the ARI Field Unit at Fort Knox, the Future Battlefield Conditions Team conducts applied research to enhance soldier preparedness through identification of future weapon systems and the methods for training to meet future battlefield conditions.

This report provides system designers with a preliminary set of user interface requirements for the new main tank's (M1A1) battlefield management system (BMS). BMS is an integrated complex of battlefield information acquisition and processing technologies intended to significantly enhance command and control (C^2).

Future development of the user requirements identified in this report will lead to the design and production of a BMS that will not only enhance C^2 and battlefield communications but also significantly reduce the small unit leader's workload.

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Technical Director

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USER INTERFACE REQUIREMENTS FOR BATTLEFIELD MANAGEMENT SYSTEMS (BMS)

EXECUTIVE SUMMARY

Requirement:

To ensure that user interface requirements were included in the design and development of the M1A1's Block II primary modification, the Battlefield Management System.

Procedure:

A prototype BMS interface was designed and developed on an Integrated Raster Imaging System (IRIS). A cross-section of small unit leaders worked with a digitized terrain data base of the Fulda Gap and menu-structured report functions to construct and edit the map displays and tactical reports needed for their respective duty positions.

User requirements were obtained by means of a structured questionnaire that addressed each of the following features and functions anticipated for BMS: terrain map and tactical overlays, variable menu for reports and messages, response keys, warnings and alerts, input devices and radio communications. In addition a protocol record was maintained of all users' comments and recommendations.

Findings:

Because of the relatively compressed area anticipated for BMS map displays, users specified the need for a variety of map features and functions that allow users to tailor the map to their immediate task requirements. Requirements included the following: selection and deletion of both man-made and natural terrain features and operational overlays, discrete map scale functions that resolve to the user's immediate area of interest, and redundant picture and symbol features for control measures and overlays. Structured menus appear promising for automated C^2 function. A number of menu modifications were proposed including the need to integrate map and report functions to reduce user report requirements. User requirements for overall configuration, size, and operating characteristics of the BMS interface were identified.

Utilization of Findings:

The findings of this research effort were provided to the Project Manager of M1A1 Block II by the U.S. Army Armor Center's Directorate of Combat Developments. Future development of these requirements will lead to the design and production of a BMS interface that will not only enhance command and control, but also significantly reduce the small unit leader's workload.

USER INTERFACE REQUIREMENTS FOR BATTLEFIELD MANAGEMENT SYSTEMS (BMS)

CONTENTS

LIST OF FIGURES

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INTRODUCTION

The Army Research Institute (ARI) conducts applied research that focuses on meeting the people-related challenges facing the Army of today and tomorrow. As part of ARI's program to train the force, the objective of the Future Battlefield Conditions Team is to enhance soldier preparedness through identification of future battlefield conditions and the methods for training to meet those conditions (Science and Technology Task 3.5.1). Future advances in weapons and equipment of the US Army, however, can increase our combat effectiveness only if those systems are usable by our soldiers. To ensure that future weapon systems are useable, ARI conducts behavioral research to provide guidelines and specifications for matching equipment designs with soldier capabilities and limitations. This ARI research product provides system designers with a preliminary set of user interface requirements for the new main battle tank's battlefield management system (BMS).

BMS is an integrated complex of battlefield information acquisition and processing technologies intended to significantly enhance combat vehicle command and control (C^2). As the proponent of Armor and BMS, the US Army Armor Center's (USAARMC) Directorate of Combat Developments (DCD) has conducted a series of evaluations on BMS prototype systems to ensure that user requirements will be included in the design and development of M1A1 BMS. One effort within this series of evaluations, the Block I BMS evaluation, identified the user informational requirements for command and control with respect to mission accomplishment. As part of the current Block II BMS evaluation, this report identified the user interface requirements with prototype BMS display features and control functions. The findings of this research effort were provided to DCD by ARI in September '85 and served as the cornerstone for DCD's final report on BMS user interface requirements provided to the Project Manger (PM) of the M1A1 Block II. Future research efforts are expected to identify the interactive requirements for BMS.

To obtain an informed set of human factor guidelines for a first-generation system design, users must have the opportunity to directly use and evaluate the system's features and functions before the system is developed and produced. To provide DCD a prototype model of BMS display panels and control functions the Lockheed Corporation, working with independent research and development funds (IR&D), joined this research effort. Lockheed, developed a reconfigurable, display demonstrator to simulate and test an array of anticipated BMS display and control features and functions.

The findings presented in this report on user interface requirements for BMS are the result, therefore, of a joint effort by DCD, ARI and the Lockheed Corporation. This effort was driven by DCD's requirement to determine guidelines and specifications for BMS production design. Although the battlefield management system comprises a host of interrelated technologies, for the sake of brevity the BMS acronym will be used throughout this report which is concerned primarily with the user interface with BMS, the BMS display features and control functions.

Design of Interface

The BMS prototype under evaluation was developed by the Lockheed Corporation and used a 1400 IRIS (Integrated Raster Imaging System) computer. The IRIS was used to generate all BMS display features and control functions. The IRIS computer was selected as the BMS simulator because it is a high performance, high resolution color computing system for 2 dimensional and 3 dimensional computer graphics. As a display simulator the IRIS is a powerful system for generating and rapidly reconfiguring display and control features. This graphic capability is ideal for quickly redesigning and evaluating interface features and functions in response to users' recommendations and requirements. IRIS's ability to communicate with other terminals (either through an Ethernet or an RS-232 serial line) would also support the evaluation of interactive requirements, critical for enhancing command and control. Future research efforts are expected to focus both on (1) behavioral measures of BMS's potential for reducing the users' workload and (2) the real-time processing and transmission of battlefield information.

The BMS base display evaluated was generated on the IRIS's 23 inch (5.8 dm), high-resolution monitor. This display could be projected in color or black and white, and at each of the following sizes: 7 inch (1.8 dm), 8 inch (2.0 dm), 9 inch (2.28 dm). The overall rectangular display region was partitioned into five "windows" or display areas corresponding to the following BMS functions: terrain map, variable menu, messages/warnings, time/date and dedicated keys. Figure 1 depicts the relative layout of these display areas. All window locations and relative display areas remained constant throughout this investigation. Users' interactions with all display features and functions were input by means of a tethered trackball and mouse device. The following section describes the BMS display features and control functions developed and assessed during this evaluation.

Description of Interface

The terrain depicted in the BMS map display window was generated from Digital Terrain Elevation Data (DTED) Level I produced by the Defense Mapping Agency (DMA). The area displayed was a 30 x 30 km region in the Fulda Gap along the East/West German border. Terrain and map features such as roads, towns, vegetation, grid and contour lines could be individually added to or deleted from this map by way of menu selections (see Figure 1). In addition a limited set of graphic control measures such as checkpoints and tanks could be annotated onto the map area by either menu selections or a free draw function. Users were able to zoom in to focus on smaller topographical areas within the overall map display region by key and menu selections that activated zoom, scroll and centering functions.

The variable menu area provided users different menus and supporting submenus for each of the main menu function keys. In Figure 2, for example, by pressing the "MAP" key the user has called-up the submenu of man-made and

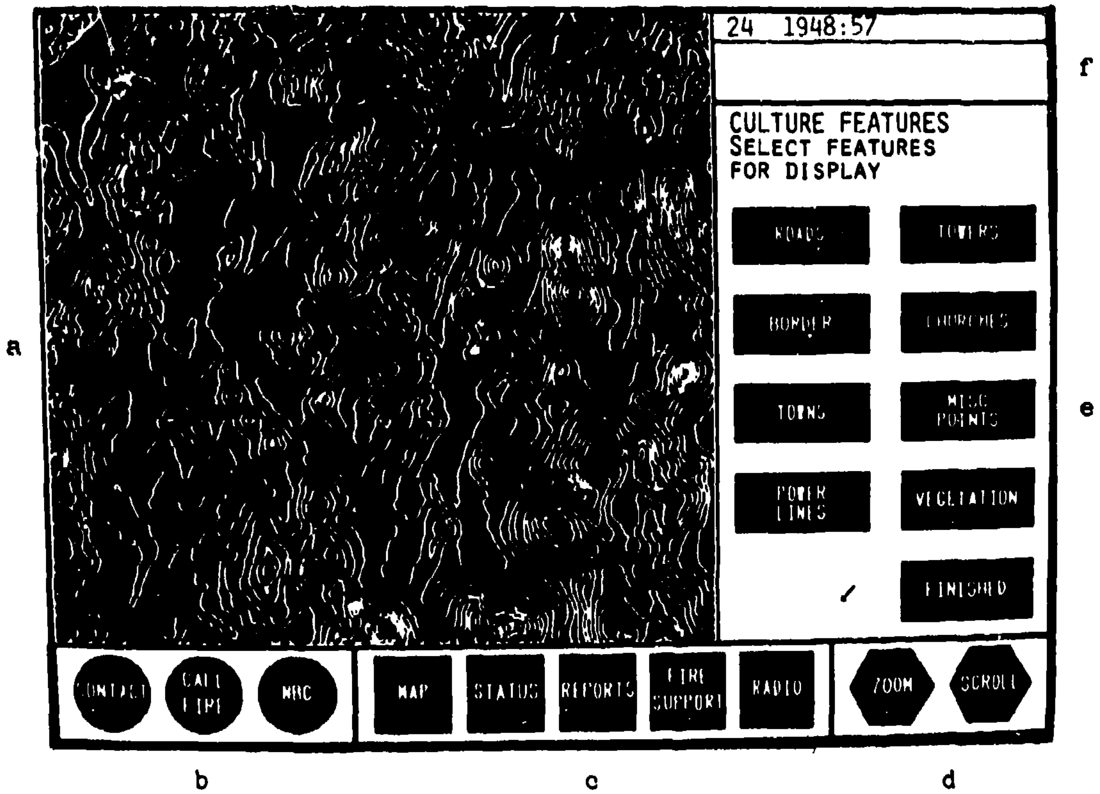

Figure 1. BMS base display depicting 30 km region in the Fulda Gap (a = map display; b = automatic function keys; c = main menu keys; d = map scale and movement keys; e = variable menu display; f = message display; and g = date and time display).

natural features and then selected five (5) of these features for the map display. Similarly this variable menu area served as the display window for composing and editing a variety of reports (e.g., SPOT, SHELL SITREP). By activating the "REPORTS" key, in the dedicated key window at the bottom of the base display, the user could call-up the menu-structured options for composing a new report or for modifying a report previously constructed. As an example of the menu-structures tested in this evaluation, the response options and sequence of pages for composing or editing a report are depicted in Figure 3. The software developed for this evaluation then presented users a menu list of different reports from which the user would select the type of report he elected to compose. The actual "composition" was accomplished by users selecting the appropriate informational elements from a series of menu lists or "pages". For example, on a subsequent page of a SPOT REPORT the user would designate the type of enemy threat being reported (e.g., ARTY, TANK, ATGM). Each menu page was clearly titled and included prompts or messages to ensure that users understood the required input.

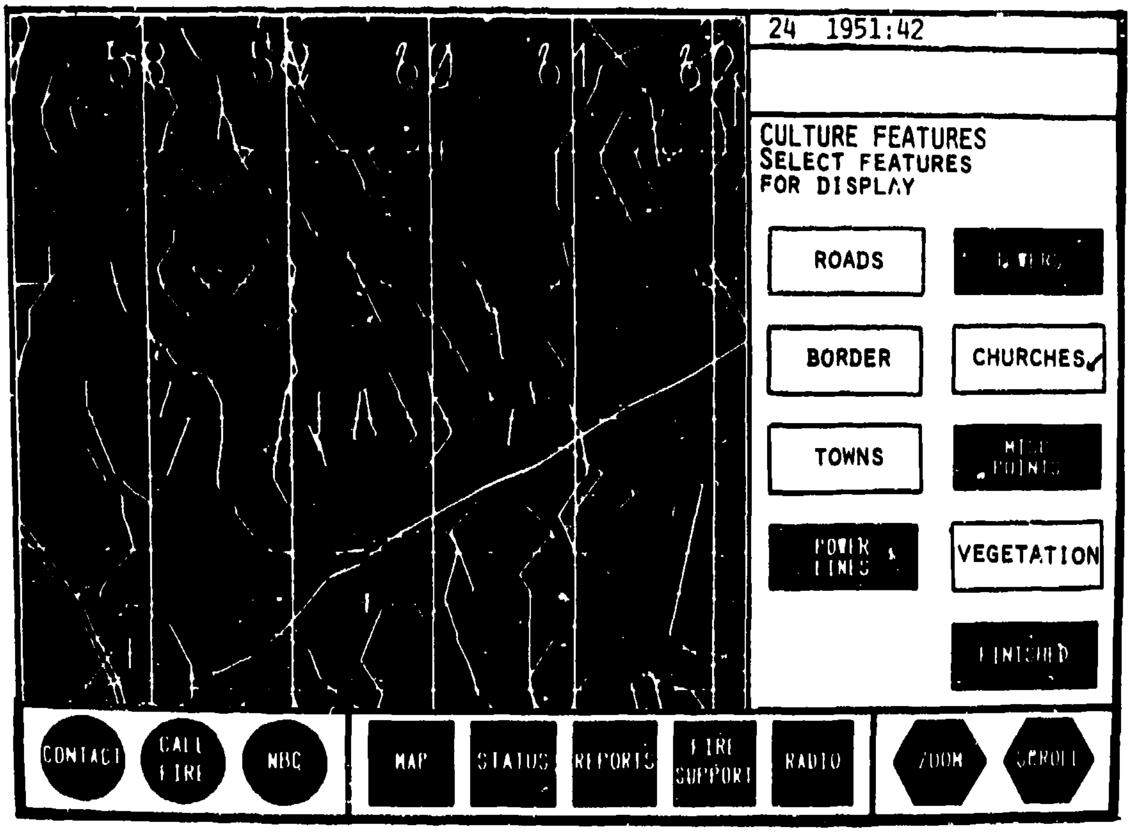

Figure 2. BMS base display depicting 5+ km region in the Fulda Gap and subset of 5 features selected for map display; user's selections indicated by reverse video (original display in color and black/white).

After completing a report the user was provided a summary page that provided a quick review of all the information selected. The user could then edit or correct this final report before "transmitting" it to other battlefield management systems. Actual transmissions of reports and messages to other users were not made during this evaluation. When the BMS prototype is upgraded for interactive command and control requirements incoming reports are expected to be presented in the same variable menu area used for composing and editing reports. The display window labeled "g" in Figure 1 was included on the base display as a designated area for alerting or cueing users that incoming messages (e.g., alerts, reports, orders) were being transmitted by other units. Finally, the remaining display area included in the base prototype was the date and time data provided at the upper right corner of the display. For the initial prototype evaluation this information was provided in a digital date/time format.

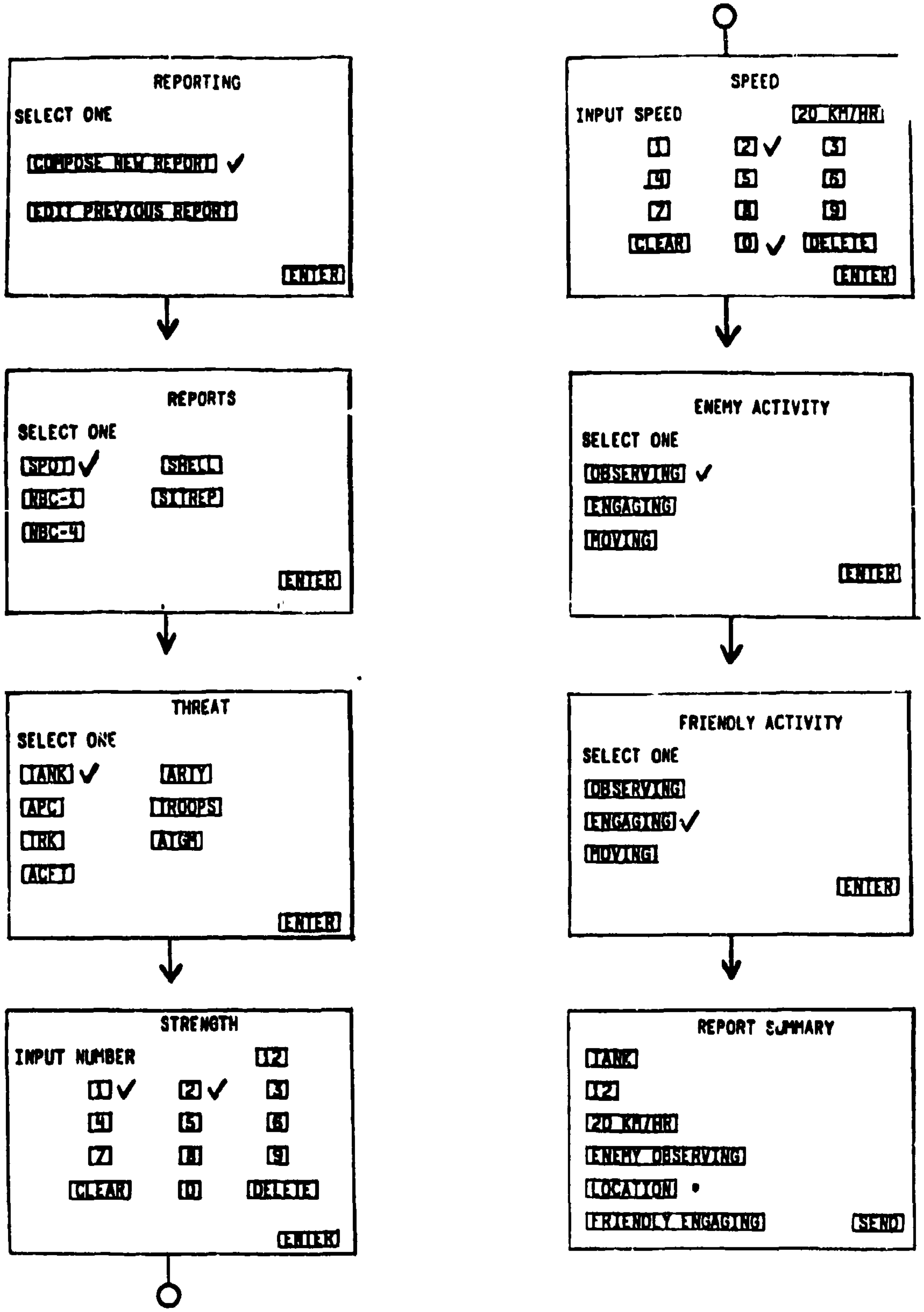

Figure 3. Menu-structure and response options for composing or editing a report (the ✓ indicates user's selections for a typical SPOT report, and the * denotes that user selections for identifying enemy location were not operational for this evaluation).

The base display also included an area at the bottom of the display for a row of dedicated or permanent function keys. The actual layout of these keys and their respective labels are depicted in Figure 1. All of these keys were "soft" keys that the user activated by moving the cursor onto the desired key with the trackball and then entering his selection by pressing the mouse button. The five square keys served as menu entry points to in itialize or call-up the main menus for a number of primary BMS functions as described previously. The hexagonal keys at the right of this window allowed the user to call-up submenus to zoom, scroll and center the digitized terrain map as required. The three round keys at the left of this region, were designed for rapid execution of critical tasks (i.e., contact reports, call for fire, and nuclear, biological and chemical (NBC) reports.

Although the software for those automatic functions was not operational at the time of this evaluation, the keys and their functions are excellent examples of BMS's potential for reducing the users' workload. For example, by simply selecting "CALL FIRE" and pointing to the target's location on the digitized terrain data base, the user should be able to accurately request and direct artillery fires to enemy targets.

Capabilities and Limitations of BMS Interface

The prototype provided by Lockheed for this effort served as a research tool for eliciting user interface requirements for the design and development of the BMS, the primary product improvement planned for the M1A1 Block II modifications. This section summarizes the operational capabilities and limitations inherent in the interface prototype at the time of this evaluation. In addition, the software enhancements anticipated for subsequent research are briefly discussed.

The primary operational capabilities of the prototype allowed users to (1) call-up and manipulate a digitized terrain data base and (2) compose and edit tactical reports independent of FM voice radio transmissions. The prototype's map manipulation functions previously described (e.g., feature selection, free draw, pan, zoom, scroll) provided the users an unprecedented and powerful technology to precisely tailor the map displays to meet their immediate areas of interest and course of action. The report functions, utilizing menu-structured informational elements provided users a unique opportunity to compose and edit tactical reports in a nonvocal manner.

A more fundamental characteristic of the prototype is that it provided users the opportunity for a direct hands-on assessment of the overall layout and integration of the various BMS features and controls. An important capability of the BMS prototype, therefore, was the generation of the base display model including the relative size, location and integration of the previously described subdisplays and functions. This capability was further enhanced by the prototype's ability to project the base display in different sizes (7-, 8-, 9- or 18- inches) and chromatic levels.

The design of the BMS interface is an extension of ARI's research program in automated command and control (C^2) systems. In particular BMS C^2 requirements are related to similar requirements being identified for the Vehicle Integrated Intelligence $V(INT)^2$ concept. Interface sequences and display/control requirements were recently proposed for the $V(INT)^2$ interface (McCallum, Harris & Fuller, 1985). A task-based analysis of information requirements for tactical maps has been developed and the resulting map information requirements could be used in future BMS research to generate representative map development guidelines across C^2 systems (Landee, Samet & Foley, 1979). System capabilities required for generating topographic displays unique to the Armor environment have also been recently suggested (Rogers, 1983). Once the preliminary BMS interface requirements are established, subsequent research should focus on incorporating the $V(INT)^2$ informational requirements and development guidelines for an integrated C^2 system across echelons.

Due to a pressing suspense deadline and the vagaries of IR&D supported development, not all of the display and control features and functions anticipated were operational at the time of this evaluation. Capabilities anticipated, but <u>not</u> operational during this evaluation include: automated key functions (NBC, CALL FIRE, and CONTACT); transmission of textual reports and graphic overlays; status and fire support functions; preparation and selective call-up of complete tactical overlays; and simulation of vehicle movement and combat dynamics. A more pervasive limitation of the current prototype was the inability to automatically collect and tabulate users' inputs and reaction times in relation to a mission oriented, or a scenario-driven, time log. This restriction prohibited the evaluation of objective measures of the users' speed and accuracy of response via BMS, relative to conventional or baseline performance standards.

Future research efforts will require that most of the current prototype limitations be redressed. In addition, many of the lessons learned from this effort are expected to be implemented. The design and development of any battlefield system is an iterative process that requires continuous refinement and modification. The results of this effort, to be presented in the following sections, have provided a firm basis for the specification of some general BMS interface requirements and clear direction about a number of research issues that should be addressed more thoroughly.

RESEARCH OBJECTIVES

The recent literature has provided numerous guidelines for the design and development of user friendly interactive computer systems. <u>Human Factors Review</u> (Muckler, 1984), for example, includes an excellent collection of articles that provide comprehensive reviews of the empirical research on human factors for visual display terminals, voice technology, dialogue design and computer assisted instruction. In addition researchers from several military agencies have recently published design guidelines more directly related to the battlefield automated systems such as "Human Engineering

Guidelines for Management Information Systems" (Hendricks, Kilduff, Brooks, Marshak, & Doyle, 1983) and "Design Guidelines for User Transactions with Battlefield Automated Systems: Prototype for a Handbook" (Sidorsky, Parrish, Gates, & Munger, 1984). These handbooks and reviews provide an invaluable base of information for designers faced with a myriad of design decisions as they develop a unique system. In general, the limitations of this literature are that these guidelines are frequently the result of research on isolated system components rather than complex systems, and the findings are often based on task requirements and criterion measures unrelated to the system under development.

More specifically, the application of these guidelines to automated system design is more of an art than a science. The guidelines previously discussed are only a generic set of recommendations and caveats that the designer should consult for preliminary planning and alternative design strategies. The designer must adapt these generalized precepts to the specific set of tasks, user characteristics, equipment and operational environment in question. As preliminary mockups of the initial design are prepared the designer attempts to incorporate any relevant guidelines into a coherent framework of operating characteristics. But the unique features and interactive requirements of the current design quickly force the designer to "extrapolate" from theoretical principles to a precise and integrated set of innovative, and often previously unspecified, system characteristics.

The development of the BMS interface designed for this evaluation followed a similar pattern. The initial design concepts were based on many of the guidelines previously established (e.g., color and shape coding, menu-structured formats, reverse-video feedback, and standardized display layouts). But after these initial design strategies were adopted, the tactics of implementation involved a series of judgments and compromises for integrating multiple, and at times competing, design guidelines and constraints.

The prototype interface was designed, therefore, to test a variety of fundamental issues with regard to BMS interface specifications such as optimal display size and layout, achromatic vs. chromatic displays, free draw versus select, menu structure and organization. Working within the generalized human factors guidelines, the objectives for this effort were to (1) design and develop a prototype interface for BMS display and control functions, (2) provide a representative cross-sample of small unit leaders the opportunity for hands-on testing of the prototype display and control functions, (3) identify the user interface requirements resulting from this test, and (4) recommend future design specifications for development of the BMS interface.

METHOD

Subjects

Twenty-nine subjects were selected to participate in this evaluation. They came from three primary student groups at Fort Knox, Kentucky: 12 from the Armor Officer Advanced Course (AOAC) for company commanders; 11 from the Advanced Noncommissioned Officer Course (ANCOC) for platoon and first sergeants, and 6 from the Basic Noncommissioned Officer Course (BNCOC) for tank commanders. These soldiers were selected as a representative cross-section of small unit leaders and as a basis for making comparisons about differences in user requirements as a function of differences in training and operational background.

Equipment

The overall design and description of the interface prototype used for this evaluation was provided in a previous section. The integrated raster imaging system of the 1400 IRIS provided a powerful computing system for manipulating or reconfiguring both 2 dimensional and 3 dimensional prototype displays and controls. The system's high resolution monitor provided the capability to test a variety of map scales and display sizes. All software programs were written in C and UNIX.

Procedure

To ensure that user requirements were based on actual hands-on assessment of the BMS, all soldiers were run in individual sessions and all recommendations and specifications were obtained as the user interacted directly with the features and functions in question. Prior to these individual sessions, initial briefings were held for each of the three classes at the experimental site. During these briefings each group was informed that the general purpose of their participation was to provide user requirements for BMS and then they were given a demonstration of the prototype's primary features and functions. These briefings were conducted to both reduce the time needed to familiarize soldiers with the system, and also to stimulate their thinking about potential BMS design and development requirements.

During their individual sessions each participant was placed in the role of "user" by providing him complete control over the BMS input devices, a mouse and trackball, and requiring him to construct his own map and report displays. To ensure that all participants contributed responses to the questionnaire items their interactions with the BMS were structured in the same order and sequence: map, reports, keys, messages, time, input devices, and radio.

Each soldier therefore began his session (two hours) with a thorough consideration of the map display and the digitized terrain data base as depicted by the prototype. The user constructed multiple sets of natural and man-made features; manipulated the map region via the zoom, scroll and center functions; and annotated the map with both free draw and graphic select functions. As he viewed each of these features and functions he was directed to complete related items on the questionnaire. Each participant then proceeded to the next functional area, reports, where he composed a variety of menu-driven report messages such as SPOT, SHELL, NBC -1 and -4. After answering the set of questionnaire items about these report functions, he proceeded in a similar manner through each of the remaining prototype features and functions and their respective questionnaire items.

Materials and Measures

The instruments used to obtain user interface requirements for this evaluation were (1) a structured questionnaire and (2) a protocol record. The questionnaire was used to ensure that users' responses were collected for a uniform set of design issues, and the protocol record served as a backup measure for capturing any users' comments and recommendations not included in the formal questionnaire.

The questionnaire included 63 items that were clustered around the following BMS features and functions: digitized map and terrain features; report composition and editing; dedicated and variable function keys; incoming messages and alerts; input devices; radio controls and displays; and degraded black and white displays. Both the clusters and the items within each cluster were presented in the same sequence for all respondents and this corresponded to the order in which respondents used and then evaluated the prototype features and controls (cf. procedures). Questionnaire items were predominantly close-ended--rank order, dichotomous, 3 pt. Likert--to provide a basis for quantification and comparison. In addition to the questionnaire addressing BMS features and functions, a brief biographical or background questionnaire was included to identify any differences in user requirements as a function of military background and training. A complete copy of the structured questionnaire is included in Appendix A for the reader's inspection.

The protocol record of users' verbal responses was maintained for both the open-ended items included in the original questionnaire and to record any additional insights or recommendations provided by the respondents that were not anticipated during construction and design of the formal questionnaire. Users' responses were transcribed by the experimenters during each session and a content analyses of these responses is provided in Appendix B.

It should be noted that all findings reported are based on the subjective evaluation by the users rather than derived on the basis of objective performance measures. But as previously described, the procedures were designed to ensure that users' evaluations were based on their immediate and hands-on experience with the BMS.

RESULTS AND DISCUSSION

The general findings for each of the major BMS interface features and functions tested during this evaluation are presented below. These results are based on responses to the questionnaire and where appropriate supplemented by additional recommendations obtained from the protocol record. The reader is referred to Appendix A where the data for each item, summarized by class and across the entire sample, are appended to a copy of the original questionnaire. This appendix ensures a comprehensive record of all detailed results and at the same time provides the reader a more accurate context for interpreting the findings to be reported. References to Appendix A for the specific findings reported below are enclosed in brackets (i.e., [A-1,1] Appendix A, page 1, item 1).

In addition, Appendix B provides a nearly verbatim transcript of users' supporting comments and recommendations, the protocol record. The content analyses of this protocol record also include the frequency and source for these statements to provide designers an index of the users' support for each modification requested, and the different requirements anticipated for various types of users. Results from Appendix B frequently summarize across a number of respondents' comments, references to this protocol record indicate the page(s) on which these comments may be found (i.e., [B-2 to B-4] Appendix B, pages 2 to 4).

Map Features and Functions

The BMS interface prototype developed for this evaluation afforded users the relatively unique opportunity to explore the capabilities and limitations of a digitized terrain data base in the context of Armor operations. The transition from conventional paper maps to the electronic map formats tested during this evaluation marks a significant change in the standard operating procedures of all military personnel. Users were instructed to consider the electronic maps as a supplement to paper maps and not as a replacement.

Comparability. A primary concern about the utility of the prototype's electronic map display was its comparability to the conventional medium of paper maps. To provide an index of comparability, users were requested to rank order ten (10) primary natural and man-made topographic features as portrayed by each medium with respect to their importance for Armor operations [A-1,1]. The transition to digitized terrain and electronic map displays resulted in no significant changes in the users' prioritization of these terrain features [A-1,2]. The five most important features selected by all users for both conventional and electronic maps were: contour lines, roads, vegetation, water and towns. The reliability of these ratings is further evidenced by the fact that the ordering for the three most important features (i.e., contour lines, roads and vegetation) were invariant for both mediums across each of the three subgroups of users tested--AOAC, ANCOC and BNCOC.

The rank order of the remaining topographic features--borders, names of towns and roads, churches, towers and power lines--were relatively the same for both conventional and electronic maps. The only noteworthy exception might be that while power lines were rated tenth or least important on conventional maps, they were rated seventh on electronic map displays. The relatively higher importance attributed to power lines on the prototype map displays may have been caused by the visual prominence or salience of this feature relative to the other terrain features depicted. The present data can not resolve this question, and the prototype as tested could not systematically vary the prominence of selected features. The potential effect of visual prominence for intentionally accenting or unintentionally exaggerating terrain features or military units and symbols is taken up in the final section.

While the overall rank orderings provide only a rough index of the comparability between between conventional and electronic may maps. They do suggest that the transition to electronic map displays may not significantly distort the users' prioritization and utilization of map information.

The protocol record, also, stresses the need to provide a BMS map format that is as comparable as possible to that of the conventional military map. The electronic map tested used a black background with a small palette of feature colors. These colors were selected to enhance feature discriminability rather than comparability with colors used in conventional map production. Participants strongly recommended that if BMS displays utilize color, the feature portrayal and coloration should correspond to conventional formats [B-2 to B-4]. This point is well taken not only with respect to issues of transfer from one medium to the other; but also with a basic premise of BMS that it is intended to supplement conventional map skills and exercises, not supplant them.

Feature Selection/Deletion. One of the primary advantages provided by a digitized data based over conventional maps is that the former can be repeatedly "tailored" to the needs of different users as well as to the immediate task requirements that each user is currently executing. The user can selectively call-up any particular combination of map features and/or operational overlays relevant to his immediate course of action. Users were unanimous in requesting that future BMS systems provide this selective call-up and delete capability [A-2, 5-6].

In addition respondents were asked what subset, of the ten features available, should be automatically called-up by BMS when users first initialize or bring up the map display, to reduce entry requests by users. Only 5 of the 10 terrain features available were requested by a majority of all participants [A-2, 7]. Those features selected were contour lines, roads, vegetation, water, and towns; the same features rated as most important previously. This result not only indicates the reliability of ratings provided by these users, but more importantly the realistic constraints imposed on the interpretation of relatively compressed map display area. The map display area was allotted less than 60% of the total BMS base display area. To ensure map interpretability, given the relatively small areas projected and tested for BMS base displays (7- to 9- inches diagonally), the requirement for the capability to selectively call-up or delete map data is further reinforced. It should be kept in mind that this subset of features was requested in the context of general Armor operations, rather than any specific mission phase or segment.

Map Scale and Movement. The need for a more adaptable map format on BMS is further accented by the users' unanimous recommendations for each of the map control/movement functions provided by the prototype: the ability to zoom in or out with respect to the users' immediate area of interest (map ranges tested were from 30 x 30 km down to 3 x 3 km regions) [A-4,12]; the ability to move any designated map area to the center of the map display window [A-4,14]; and the ability to move the map up or down, left or right [A-4,13].

The protocol record, however, strongly suggests that any continuous zoom feature be coupled with a users' set of discrete zoom levels that automatically resolve to lower echelon areas of interest (i.e., 30 x 30 km for company commanders [B-3, B-4], 6 x 6 km for platoon leaders, and 3 x 3 km for individual tank commanders). Questionnaire items assessing the users preferred map scales indicate that for the levels investigated (i.e., company commander, platoon leader, first sergeant, platoon sergeant and tank commander) a 1:50,000 is the most preferred, and a 1:25,000 is their second choice [A-3,11]. This preference for 1:25,000 over 1:125,000 suggests that even at the company level, small unit commanders are generally willing to sacrifice topographical range for greater detail on their BMS map displays.

It should be noted that a position location or positive navigational system was not available on this BMS prototype. Additional research should be conducted to determine users' recommendations and specifications regarding this feature (e.g., "In what area of the map display should your vehicle be located?"). In addition, the protocol records suggest the need for a closer look at the problems of disorientation that might arise as a result of system-induced map and symbol movements [B-5, B-6].

Draw or Select. A series of questionnaire items were directed at BMS functions related to the graphic generation and representation of battlefield information such as operational overlays. Users were first allowed to annotate their maps with both a free draw function (using the mouse and trackball) and a vehicle or control measure, select function. They were subsequently asked whether each of the tactical overlays--operational, threat, fire support and obstacles--should be generated by either a free draw or select function [A-3,8]. While BNCOC students appear significantly more inclined than AOAC and ANCOC respondents to select rather than draw these graphics; the overall record reveals a very mixed pattern of results across all three classes. A mitigating factor is that users' preference for free draw may have been lowered because they were forced to draw using a mouse and trackball rather than with a lightpen or on a touch sensitive screen, and this issue should be further investigated. Nevertheless, the results suggest that in view of the wide range of both potential users and types of graphic overlays required, BMS should include both draw and select functions for the production of graphic data.

Picture or Symbols. A central issue in this area of graphic representation is how best to generate a standardized set of tactical features for constructing operational overlays. These features must distinguish between various types of vehicles and weapon systems for both friendly and enemy forces as well as an extensive set of military control measures such as check points, obstacles, target reference points, phase lines. The military has developed a formal set of symbologies for all standard tactical features (Field Manual 21-30) and over 70% of all users requested that system-generated graphics allow users to select these symbols rather than pictorial images [A-3,9]. The efficiency of the symbolics is apparent especially in the representation of multi-vehicle forces (e.g., platoon, company, battalion). But military unit symbols have been found to have low or negative transfer of training, high potential for confusion and low association value (Jarosz & Rogers, 1982). In addition, symbols must be learned and require a higher order of processing than the more intuitive representations of pictorial images. Battlefield conditions such as the turbulence due to attrition and the stress associated with combat may seriously impair the soldier's understanding of tactical overlays that rely entirely on symbolic features. In addition it should be noted that many of the users tested (29%) requested pictorial images over military symbology [A-3,9].

Given the relatively minor system memory requirements involved, it is recommended that redundant coding systems be included in BMS to override degrading battlefield conditions that may impair soldiers' memory and comprehension. All tactical features should be coded symbolically, pictorially and textually. The user would have the option of representing tactical features on his own BMS in either a symbolic or pictorial mode, although all transmissions between users would revert to a uniform digital code. Additionally by providing a textual label and definition to the user, especially the new user in cases of attrition, he could quickly review the name and key information about the feature in question (e.g., the personnel and weapon system characteristics of a motorized rifle battalion).

Additional Map Issues. A primary assumption in the design of the BMS prototype tested was that the map displays should be assigned to a dedicated or permanent window on the BMS display. Protocol records strongly suggest, however, that a continuous map display is neither required or preferred [B-7]. Users were quite willing, to trade-off the previously dedicated map area for enlargement of the reporting window during periods of reduced activity (e.g., assembly area, consolidation).

Finally, the protocol record strongly suggests that a number of map functions not available on this prototype be included in the BMS display features: oblique or three dimensional views of surface configurations; line of sight; and graded elevation shading [B-2 to B-6].

Report Features and Functions

A reality of human communication is that speaking is a more fluent and informative modality than writing. BMS faces a serious challenge in its goal of bypassing the conventional voice mode of communication--the FM radio. Aware of this limitation, this research paid considerable attention to the issue of communicating and reporting via BMS.

It should be noted that the findings reported in this section are primarily restricted to the menu formats designed for this BMS prototype. While arguments for a keyboard transcription of all reports or preformatted form-filling alternatives to such menus might be considered, the time required for the user to generate each alphanumeric character must not be underestimated. In view of the need for more rapid, accurate and automated report functions the BMS prototype tested was designed around menu formats from which users only selected, rather than generated, their report elements.

Menu Structure. Working within the confines of a dedicated report window (the variable menu display (e) depicted in Figures 1 and 2) rather than the entire BMS display area, this menu structure generally required users to (1) review and select from 7 to 10 "pages" of information to be included in their reports and (2) provide 14 to 20 key entries to complete a single report (e.g., SPOT, SITREP, NBC). It should be noted that all doctrinally prescribed elements within each report were included (e.g., crater width, type of agent, duration of the attack etc.) for this evaluation which in part contributed to their length. To overcome the complexity of this reporting function, a number of potential design modifications were investigated.

Before discussing these modifications, it is noted that 79% of all users described the menu structures designed and tested for this evaluation as "easy" or "very easy" to use [A-6,24] and 89% reported that this extended set of report elements ensured that their final reports were complete and accurate messages [A-5, 17]. Users' description of the menu-structured reports as "easy" indicates that they had surprisingly little difficultly understanding how to select the appropriate information (e.g., tank, aircraft, personnel) or how to step through the various pages from which they selected all the information required for their report. This is further reinforced by the fact that 79% of all users found that the editing functions for correcting and updating their reports were acceptable [A-5,27]. Users were able to edit their reports on each page as they proceeded through the informational elements, or at the end of their report on the summary page. From this summary page that listed all the information the user had selected, the user could select any element and return directly to the original page to edit his report (e.g., change in speed, number of vehicles observed etc.). This information was immediately updated on the summary page for a final inspection before "transmission".

Menu Modifications. Although the menu structure for report composition and editing appears to be a promising model for the BMS design, considerable attention must be directed at modifications to reduce the number of pages and key entries required for this function. It should be recalled that during this evaluation standardized display areas were maintained and the map area was retained at all times for continuous terrain and situation displays. As indicated previously, users clearly indicated that during periods of reduced activity or "lulls in the battle" they did not feel the map was required and therefore, at such times, most of the BMS display could be used for report functions [B-7]. This expanded display region would certainly reduce the number of pages required for reporting; and if coupled with a lightpen or touch-interactive screen, discussed later, the users' entries required for information selection could be made more easily.

Other modifications for streamlining report requirements might be to reduce either the number of reports included in the BMS software or to reduce the number of informational elements required to complete each report. Both alternatives were addressed by the questionnaire and a review of the results will provide BMS designers the users' preliminary guidelines concerning the frequency of occurrence for various reports [A-4,15] and the relative importance of the informational elements doctrinally prescribed for certain reports (e.g., SPOT) [A-7,28]. In addition, the protocol records stress the need for a common format across all reports such as "who", "what", "where", and "when" or the SALUTE (size, activity, location, unit and time) format [B-6 to B-8]. Implementation of any alternatives listed in this paragraph, however, may require doctrinal changes that must be formally sanctioned.

Protocol records also stress the need for additional BMS specifications related to the report function. For example, users require system-generated wiring diagrams that clearly depict the structure of the hierarchical menus used for both reporting and other functions provided by BMS, and a cursor control dialog that automatically shifts the cursor to the next most probable data entry [B-6 to B-8]. This automated cursor "homing" function would reduce the time needed to complete reports and is consistent with questionnaire results where users recommended that the organization of menus, and informational elements within menus, be structured "by frequency of use" [A-7,30]. A similar wiring diagram could be provided by BMS to display the routing patterns of both incoming and outgoing messages and reports. This diagram, for example, might illustrate how an operations order was automatically partitioned to the requirements of lower echelons and precisely what information was disseminated and to which levels of command.

Additional Detail. When designers attempt to preprogram the informational elements required for tactical reports into the BMS software, to reduce user-generated alphanumeric entries, inevitably not all contingencies will be foreseen. The structured interview directly addressed this need for "additional detail" to be added to the reports and the respondents' recommendations as to how this detail should be entered by the user into BMS. In general, users suggested that for their most frequently issued reports--SPOT and SITREP--additional detail may "often" or at least "sometimes" be required [A-5,18]. For the less frequent reports such as NBC 1, 4 and SHELL they reported less of a need for additional detail, but few were willing to rule out this possibility.

Potential solutions assessed by the questionnaire for entering this additional detail were a complete typewriter keyboard with all alphanumeric characters and a smaller (single hand) key pad. While officers from AOAC were evenly split (50% Yes, 50% No) about introducing a full keyboard onto the tank, nearly 75% of the students from ANCOC responded "No" [A-5,21]. The keypad received a much higher endorsement from most users [A-5,20], but there are reservations about this data. The keypad question did not specify what keys might be included on the keypad or their arrangement. Respondents faced with the dilemma of additional detail to be reported, yet not wanting a "typewriter" on the tank, may have opted for the unspecified keypad. In summary, while the need for an additional detail function is indicated, the results are inconclusive as to a viable BMS specification.

Integrated Functions

One major conclusion, anticipated in the prototype's design, and confirmed by the protocol records, is that BMS must integrate the map and report functions [B-6 to B-8]. Nearly all military communications are based on the spatial geometry of the battlefield. The real potential for BMS as a command and control system is to link spatial and verbal information, to synthesize map/graphic data with verbal/reports and orders. This synthesis is not only critical to meet BMS expectations as a force multiplier, it is also essential to providing commanders a BMS that minimizes the users' requirements. Two examples will be briefly discussed to illustrate this potential.

The first example, is the specification of three automatic functions --CALL FIRE, NBC, and CONTACT--originally designed for this prototype, but not fully operational at the time of this evaluation. All three of these keys operate on the assumption that spatial and verbal reports will be integrated by BMS. To call for indirect artillery fire, for example, the user might 1) first press or enable the "CALL FIRE" key, 2) point, or move the cursor, to the map area of enemy activity, and 3) then press a "SEND" key. A request for suppression by indirect fire is then immediately sent to the appropriate receiver (fire support team, artillery, etc.). Anyone familiar with the relatively complex and time consuming procedures required for target location (e.g., polar plot, shift from a know point) and the frequency of misdirected fires, can readily appreciate how important the integration of map and report functions is for BMS.

The next example is a proposed modification designed to provide users with the most streamlined report function acceptable. By integrating spatial and alphanumeric data into the same report, SPOT and SITREP reports could be completed on one "page" of the BMS display using the "who", "what", "where", "how many", and "when" format. "What" and "when" should be data automatically stamped to each BMS report when the report concerns a current activity. "Where" would be indicated by touching or positioning a cursor on the map display. "What" and "how many" could be entered from the same menu page if generic descriptions (e.g., heavy or light track, wheel, fixed or rotary air, and troops) were listed adjacent to a numeric keypad.

Response Keys

The BMS prototype tested did not include a separate keyboard or keypad for data entry. The prototype employed "soft" keys on the base display to allow for software rather than hardware "fixes" or "retrofits" to BMS units once they are fielded. All keys and key functions were activated by moving the cursor to the appropriately labeled key area via the trackball and activating or "pressing" the key by pushing the mouse button.

In general, users clearly supported the requirement that BMS displays include the array of main function (i.e., MAP, REPORT, RADIO, STATUS, and FIRE SUPPORT) and automatic function keys (i.e., CONTACT, CALL FIRE, NBC) configured on the prototype. Ninety percent of all users requested that these keys be included in a dedicated area as permanent keys on the BMS displays [A-8,31]. In addition the prototype's use of reverse-videoshading, to indicate that a key had been selected and the key function activated, was requested by 93% of all users [A-8,32]. The protocol records also suggest the need for additional key options such as a permanent function key leading directly to map annotation features, rather than stepping through a menu structure, and an "ESCAPE" key or other feature to immediately terminate a current activity in favor of a higher priority requirement [B-8].

Given the restricted area projected for BMS displays (7- to 10- inches), the legibility of key labels and other display data was a primary concern of this investigation. The rapid display demonstrator was able to rescale the entire base display area to diagonal dimensions of 7-, 8-, and 9- inches for users' evaluation and 18- inches for the initial class briefings. For character sizes and resolution levels tested, 96% of all users reported that the 9" configurations produced key and menu labels that could be easily read. Over 75% of all participants were willing to accept an 8" display size, but more than two thirds of the participants reported that the 7" display was too compressed [A-8,34]. Protocol records provide a number of recommendations for further enhancing legibility such as abbreviated key labels and color coded keys [B-8].

Message and Alert Features and Functions

The BMS prototype did not have a fully operational software program for messages and alerts. A display window for receiving incoming messages (cf. Figure 1) had been designed and incorporated into the prototype BMS displays evaluated by our sample of users. In addition, mockups of various alerts and signals were developed and users were given a detailed description of how the message and alert functions might operate with respect to the prototype's supporting display and control systems. On the basis of this orientation users' reactions were solicited to provide designers at least some preliminary guidelines for BMS message and alert functions.

Users' awareness of BMS's critical role in enhancing command and control is reflected in their unanimous endorsement of the need for a permanent window or display area dedicated solely to incoming alerts and signals [A-9,37]. In addition 97% of all respondents approved of the location--upper right hand corner of the display window--configured for this evaluation [A-9,38]. It is expected that BMS may prioritize incoming messages and alerts by importance, 93% of the respondents specified they must be able to override this automated function [A-9,39]. In addition, 86% of all users recommended that incoming verbal or map/graphic communications not be entered onto their displays until they pressed a "RECEIVE" key [A-9,42]. Similarly, the majority of all users realized that "reception" of a message is not the same as acknowledgement. BMS, therefore, should not include an automated acknowledgement function, but require a manual acknowledgement to ensure users' reception of the message. [A-9,41].

Users strongly endorsed the need for flashing or blinking visual alert and message signals, and 86% requested that they be coupled with a redundant auditory signal such as a beep or buzzer sound [A-9,42]. To ensure that the auditory signal was heard, many of the respondents' protocol statements urged that this signal be sent over the FM radio or transmitted to the user via the CVC headset. In addition, users recommended that the visual signals be coded (e.g., flashing red for most critical signal) to indicate its relative importance [B-9].

Date and Time Features and Functions

The BMS prototype included a date, time window at the uppermost right hand corner of the display (cf. Figure 1) and continuously provided this information in a digital format with the day of the month preceding the hours/minutes/seconds in the following manner: 11 1400:59. Users unanimously endorsed this location [A-10,48] and 97% approved of the format [A-10,45]. Ninety three percent of all users felt this information was important enough to warrant continuous display and a permanent window [A-10,47].

This evaluation also attempted to identify users' needs for additional BMS time functions. For example, 89% of the respondents requested that the time format be annotated with Alpha and/or Zula indicators [A-10,46]; and 79% stated that an H hour calculation (e.g., H -90 minutes, H +24 minutes) would be a useful function for monitoring their progress in terms of backward planning and rate of execution [A-10,49]. The protocol record also includes a number of requests by users for an alarm function for such things as timing their operations and sleeping [B-9].

Input Devices

As previously indicated, the BMS prototype tested used a mouse and trackball control unit for all user inputs and interactions. Users' reservations about these input devices are clearly indexed in the results section under a series of items assessing their suitability for various functions (i.e., selecting menus, drawing, locating objects on the map) [A-11,52]. Their most serious criticism of the mouse and trackball was directed at draw functions, and 72% of all users felt that these controls (as tested) were inadequate. Users' prioritization of alternate input systems indicate their preference for more natural or intuitive controls such as a touch-sensitive screen or lightpen.

This report's results should be regarded as tentative with respect to users' specifications for input devices. A limitation of this evaluation is that the preferred input systems were not provided for hands-on tests. In addition, the laboratory setting does not approximate the vehicle turbulence associated with cross country, high speed maneuvers where user inputs with a lightpen or touch-screen interface may be misdirected by vehicular motion. In contrast, cursor designation via a trackball can be verified independently by the user prior to the entry of that data into the system, since the mouse key press is a separate entry function. Finally, a mouse/trackball or parallel input device might prove more workable if mounted directly to the BMS display rather than configured as a separate control unit as in this evaluation. Ninety three percent of all users requested a mounted, rather than separate, mouse/trackball configuration if this input system is implemented [A-11,53]. In conclusion, the specification of a BMS input device requires a more extended hands-on evaluation of each candidate control system and ideally a field setting with cross country movement.

Radio Features and Functions

As a digital burst, operationally secure mode for transmitting both text and graphic data, BMS is expected to provide a powerful alternative to voice communications over the FM radio. BMS is primarily a command and control system and should become the preferred mode for both critical and sensitive data transmissions. In addition to its role as a back-up communication channel, however, the radio may remain as a vital "human" link between soldiers engaged in deadly and often isolating combat situations.

For this evaluation several potential BMS functions were assessed that might support, or make easier, radio frequency and channel designation. Pressing the main function key entitled "RADIO" brought up a display page with a number of automated functions. The design of this page was tailored to user echelon levels and depicted channels or nets for battalion-down communications. It was anticipated that BMS should automatically dial in and update both primary and anti-jam frequencies in accordance with Communication Electronic Operations Instructions (CEOI). This prototype feature was intended to preprogram and automate as many communication operations as possible. Ninety-three percent of all users rated this function as "useful" to "very useful" [A-12,55] and 96% indicated that the display layout was "clear and easy to interpret" [A-12,56]. The value of this function, however, may be limited to conventional fixed-frequency systems, and less useful in the case of more modern frequency hopping single channel ground/airborne radio subsystems (SINCGARS).

In addition, 97% of all users recommended that BMS automatically select the receive-only, auxiliary channel, when a new transmit/receive net is designated [A-12,57]. A review of the results provides user specifications, default values, for this automated "aux" setting for each of the following positions: tank, platoon and company commanders, platoon and first sergeants.

Black and White Displays

The final task for each respondent was to reconsider the portrayal of map features provided by a digitized terrain data base restricted to only black and white, achromatic displays. Users operating with only black and white (B/W) displays, requested the same subset of features be automatically generated that they had chosen for color displays: contour lines, roads, water, vegetation, and towns [A-13,61]. And in general their relative ratings of importance across all ten features were unchanged from their ratings for chromatic map displays [A-13,59]. But the black and white display clearly impairs feature discriminability and map interpretation. Their attempts to declutter the B/W display and increase discriminability are evident in that the majority of ANCOC and BNCOC students requested that only 4 features be automatically initialized in the B/W mode contrasted with the 5 requested on the color displays (water was excluded), and in the lower probability of selection for all features.

The black and white displays were tested in the event that flat panel technologies have not developed to the level of full color displays by the 1988 projected BMS milestones. While users' preference for color was nearly unanimous, a number of participants reported they felt comfortable with B/W only displays and that B/W was a viable, if least preferred, display format. In response to a potential trade-off decision, 69% of all users requested a color display that was fixed or stationary (given the extended depth of a CRT-based system) over a more portable, presumably tethered, flat panel technology [A-14,62].

In conclusion, the interpretability of a B/W BMS display is heavily dependent upon the feature/overlay select and delete function previously discussed. If the map can be repeatedly "tailored" to each user and each task by delimiting the display to only the smallest set of relevant terrain features, then a B/W or monochromatic BMS display should still prove a powerful technology for enhancing command and control of Armor operations.

SUMMARY

This report has identified a preliminary set of user interface requirements for BMS. The goal of this effort was to ensure that fundamental user requirements were included in the earliest stages of BMS design and development. To provide this information in a timely manner to the Project Manager for the M1A1 Block II, this evaluation has attempted an initial assessment of a broad range of user requirement issues for BMS. The evaluation addressed not only the overall size and configuration of the BMS base display, but also most of the major operating features and control functions anticipated for BMS. Further research on and refinement of these BMS user requirements issues is clearly needed.

A more thorough investigation of many important user requirements will require refinements to the BMS interface prototype. As discussed previously future efforts will require that a number of limitations in the current prototype be redressed including: automated key functions; interactive transmissions; enhanced symbol and graphic generation features; menu modifications; and simulation of combat dynamics on the map and terrain display. Most importantly, this revised interface must include the capability of automatically collecting users' input and reaction times in relation to a scenario-driven time log. This would allow the evaluation of objective measures of the users' speed and accuracy of response via BMS, relative to conventional or base line performance standards.

Finally, while BMS is expected to significantly enhance command and control this evaluation has underscored the fact that it may require a significant change in the users' standard operating procedures, such as the shift from vocal (FM radio) to non-vocal communication and from paper maps and conventional overlays to digital terrain and tactical displays. Both users and designers must attempt to streamline and reformulate these standard operating procedures to maximize the innovative potential of BMS. As part of DCD's Block II BMS evaluation, this report has initiated this effort by asking users to specify both their current and future command and control requirements given the automated functions of a prototype BMS.

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APPENDIX A
USERS' BMS INTERFACE QUESTIONNAIRE AND RESPONSE DATA

Map

1. When using conventional military maps, how important are the following terrain features. Please rank these features from 1-10 with 1 indicating most important feature and 10, least important.
[Features are reordered by importance ratings across entire sample, rather than by their original order on questionnaire.]

	AOAC	ANCOC	BNCOC	ALL
contour lines	1	1	1	1
roads	2	2	2	2
vegetation	3	3	3	3
water	4	4	5	4
towns	5	5	6	5
borders	7	6	4	6
names of towns, roads, etc.	6	7	7	7
churches	9	8	8	8
towers	8	10	9	9
power lines	10	9	10	10

2. When using these BMS maps on your display, how important are the following terrain features? Please rank these features from 1-10 with 1 indicating most important feature and 10, least important. (Assume shading)
[Features are reordered by importance ratings across entire sample, rather than by their original order on questionnaire.]

	AOAC	ANCOC	BNCOC	ALL
contour lines	1	1	1	1
roads	2	2	2	2
vegetation	3	3	3	3
towns	7	4	4	4
water	5	5	6	5
borders	4	6	5	6
power lines	9	7	7	7
names of towns, roads, etc.	6	8	10	8
churches	10	9	8	9
towers	8	10	9	10

3. What changes or improvements would you recommend for displaying the terrain features provided by BMS? Write in your recommendations for each of the following: [SEE REPORT]

4. In general, are there any other terrain features that you feel are important that should be included on the BMS? Please list those below. [SEE REPORT]

5. Do you like the feature of being able to add or delete selected terrain features on the map display?

	AOAC	ANCOC	BNCOC	ALL
Yes	100%	100%	83%	97%
No	-	-	17%	3%

6. Would you like this feature to include ability to selectively place your military overlays (opns, threat, fire support, and obstacles) onto your display map?

	AOAC	ANCOC	BNCOC	ALL
Yes	100%	100%	100%	100%
No	-	-	-	-

7. When you "initialize" or bring up the map display for the first time, which of the following terrain features do you think should be automatically provided? Please check only those features you want automatically provided. [*s indicate those features selected by at least a majority of respondents in that group.]

	AOAC	ANCOC	BNCOC	ALL
roads	*	*	*	*
vegetation	*	*	*	*
towns	*	*		*
water	*	*		*
contour lines	*	*	*	*

[Features not selected by a majority of respondents are: borders, power lines, churches, towers, names of towns, roads, etc.]

8. In general, would you prefer to draw in the following graphic features, or select these symbols from a menu and locate them on the map.

		AOAC	ANCOC	BNCOC	ALL
Operational graphics	Draw	64%	73%	17%	58%
	Select	36%	27%	83%	42%
Threat graphics	Draw	38%	27%	17%	30%
	Select	62%	73%	83%	70%
Fire support graphics	Draw	33%	36%	17%	31%
	Select	67%	64%	83%	69%
Obstacle graphics	Draw	43%	27%	17%	33%
	Select	57%	73%	83%	67%

9. When selecting elements such as tanks or APCs to be placed on the map, would you prefer to select from a menu of standard military symbols or from a menu of picture images.

	AOAC	ANCOC	BNCOC	ALL
Symbols	64%	67%	82%	71%
Pictures	36%	33%	18%	29%

10. When these same elements are displayed on your map, would you prefer standard military symbols or picture images?

	AOAC	ANCOC	BNCOC	ALL
Symbols	83%	80%	67%	79%
Pictures	17%	20%	33%	21%

11. Which of the conventional map scales would you prefer to use most as a platoon commander, as a company commander? Rank order for each position from 1-3. [Map scales are reordered by preference ratings, rather than by their original order on questionnaire. NCOs ranked map scales for TC, PSG, and 1SG.]

[For all positions combined]	AOAC	ANCOC	BNCOC	ALL
1:50,000	1	1	1	1
1:25,000	2	2	2	2
1:125,000	3	3	3	3

12. Does the ability to ZOOM in and out appear to be an important map control feature?

	AOAC	ANCOC	BNCOC	ALL
Yes	100%	100%	100%	100%
No	-	-	-	-

13. Is the pan function that allows you to move the map around an important map control feature?

	AOAC	ANCOC	BNCOC	ALL
Yes	100%	100%	100%	100%
No	-	-	-	-

14. Is the centering function an important map control feature?

	AOAC	ANCOC	BNCOC	ALL
Yes	100%	100%	100%	100%
No	-	-	-	-

Reports

15. The BMS report menu lists six different reports that can be composed and transmitted. How frequently are these reports used? Would you rank the following reports from 1-6 for frequency of use with 1 indicating most frequent report and 6, least frequent.
[Reports reordered by overall frequency ranks, rather than their original order on questionnaire.]

	AOAC	ANCOC	BNCOC	ALL
SPOT	1	1	1	1
SITREP	2	3	2	2
NBC 1	3	2	3	3
SHELL	4	4	4	4
NBC 4	5	4	4	5
MIJI	6	6	6	6

16. Are there any additional reports that need to be included on BMS? [SEE REPORT]

17. Although your display window shows the current tactical situation, the report elements such as unit, location, were specified to ensure that reports would be complete and accurate messages. Is this report format a useful reminder of all the information needed?

	AOAC	ANCOC	BNCOC	ALL
Yes	92%	100%	67%	89%
No	8%	-	33%	11%

18. How often would you need to add any additional detail to these reports?

Please check one for each type of report:

		SPOT	NBC 1	NBC 4	SHELL	SITREP	MIJI
[For all classes combined]	Never	28%	62%	59%	34%	27%	48%
	Sometimes	31%	26%	33%	55%	38%	43%
	Often	41%	12%	8%	11%	35%	9%

19. What types of detail might you want to include that is not listed? [SEE REPORT]

20. Would you recommend that BMS include a keypad with a few keys (single hand) for entering additional information?

	AOAC	ANCOC	BNCOC	ALL
Yes	92%	64%	33%	69%
No	8%	36%	67%	31%

21. Would you recommend that BMS include a complete typewriter keyboard for entering additional detail information?

	AOAC	ANCOC	BNCOC	ALL
Yes	50%	27%	67%	55%
No	50%	73%	33%	45%

22. Is the location of this display area for reports acceptable?

	AOAC	ANCOC	BNCOC	ALL
Yes	75%	100%	83%	86%
No	25%	%	17%	14%

23. Is having to enter data on up to five menu pages to complete a report an acceptable number?

	AOAC	ANCOC	BNCOC	ALL
Yes	17%	55%	50%	38%
No	83%	45%	50%	62%

24. How confusing or easy did you find stepping through the menus to be?

	AOAC	ANCOC	BNCOC	ALL
Very Easy	8%	36%	33%	25%
Easy	42%	64%	50%	54%
Confusing	50%	-	17%	21%
Very Confusing	-	-	-	-

25. Are there times you might want to send partial reports?

	AOAC	ANCOC	BNCOC	ALL
Yes	100%	91%	83%	93%
No	-	9%	17%	7%

26. Did the summary page provide you a complete copy of the message you are about to report?

	AOAC	ANCOC	BNCOC	ALL
Yes	83%	91%	100%	90%
No	17%	9%	-	10%

27. Were you able to edit or change these reports in a manner that you found acceptable?

	AOAC	ANCOC	BNCOC	ALL
Yes	67%	90%	83%	79%
No	33%	10%	17%	21%

28. Rank order (1-8), in order of importance, those elements of the Spot Report which you think are the most important with 1 indicating most important element and 8, least important.
[Elements are reordered by importance ratings across entire sample, rather than by their original order on questionnaire.]

	AOAC	ANCOC	BNCOC	ALL
enemy size	1.5	1	1	1
enemy location	1.5	2	2	2
enemy activity	4	2	3	3
enemy equipment	5	5	4	4
obserer ID	3	4	5	5
your activity	6	6	7	6
time of observation	7	7	6	7
enemy unit ID markings	8	8	8	8

29. If you are working on a report and get interrupted, where would you like to return to when you continue working on that report?

	AOAC	ANCOC	BNCOC	ALL
At the beginning	8%	-	33%	10%
Where you left off	42%	64%	50%	52%
Summary page	50%	36%	17%	38%

30. Given the menu structures in BMS, how do you think the menu items should be listed? Rank order from 1 to 3 with 1 indicating your first preference and 3 your last preference.

[For all classes combined]

	1ST	2ND	3RD
Alphabetically	15%	10%	75%
By frequency of use	61%	39%	-
By degree of importance	50%	35%	15%

Keys

31. Do you like having the main function keys appear as permanent keys on the display?

	AOAC	ANCOC	BNCOC	ALL
Yes	92%	91%	83%	90%
No	8%	9%	17%	10%

32. Reverse video/shading was used to indicate that a key or feature had been selected. Is this reverse video an important display feature?

	AOAC	ANCOC	BNCOC	ALL
Yes	92%	100%	83%	93%
No	8%	-	17%	7%

33. Would you prefer that the label for a key be overlayed on the key or displayed beside the key?

	AOAC	ANCOC	BNCOC	ALL
On the Key	100%	100%	100%	100%
Beside the Key	-	-	-	-

34. Could key labels be easily read at each of the available display sizes?

	AOAC	ANCOC	BNCOC	ALL
7" Yes	25%	50%	20%	33%
No	75%	50%	80%	67%
8" Yes	73%	80%	80%	77%
No	27%	20%	20%	23%
9" Yes	92%	100%	100%	96%
No	8%	-	-	4%

35. Was the displayed keypad for entering numeric data easy to use?

	AOAC	ANCOC	BNCOC	ALL
Yes	92%	100%	100%	97%
No	8%	-	-	3%

36. Did the "delete" and "clear" keys allow you sufficient control for changing data entries?

	AOAC	ANCOC	BNCOC	ALL
Yes	100%	91%	100%	97%
No	-	9%	-	3%

Messages and Alerts

37. Do you like having a permanent area or window on the display that indicates incoming information such as warnings, alerts, and reports?

	AOAC	ANCOC	BNCOC	ALL
Yes	100%	100%	100%	100%
No	-	-	-	-

38. Is the location of this information on the BMS display acceptable?

	AOAC	ANCOC	BNCOC	ALL
Yes	92%	100%	100%	97%
No	8%	-	-	3%

39. After being prioritized, the BMS currently displays information in the order received, would you like the option to select the order of information to be displayed?

	AOAC	ANCOC	BNCOC	ALL
Yes	100%	82%	100%	93%
No	-	18%	-	7%

40. In order to not write over current displayed information, the BMS does not display incoming information until you touch the receive key. Do you like this feature?

	AOAC	ANCOC	BNCOC	ALL
Yes	83%	91%	83%	86%
No	17%	9%	17%	14%

41. Would you like the system to automatically acknowledge for you when you receive a message and touch the receive key?

	AOAC	ANCOC	BNCOC	ALL
Yes	50%	73%	67%	55%
No	50%	27%	33%	45%

42. Should any visual signal used for alerts or incoming messages be a blinking or flashing signal to insure they are detected?

	AOAC	ANCOC	BNCOC	ALL
Yes	67%	100%	100%	86%
No	33%	-	-	14%

43. Would you like an additional alerting cue such as an audible beep or buzzer?

	AOAC	ANCOC	BNCOC	ALL
Yes	75%	91%	100%	86%
No	25%	9%	-	14%

44. Is this permanent message area necessary for any other information? If so, what kinds of information: [SEE REPORT]

Date, Time

45. Is the data displayed in the Date, Time window in an acceptable format or arrangement?

	AOAC	ANCOC	BNCOC	ALL
Yes	92%	100%	100%	97%
No	8%	-	-	3%

46. Should you have the flexibility to place A or Z after time to reflect if time is in alpha or zulu?

	AOAC	ANCOC	BNCOC	ALL
Yes	82%	91%	100%	89%
No	18%	9%	-	11%

47. Should this Date, Time information be provided continuously?

	AOAC	ANCOC	BNCOC	ALL
Yes	92%	91%	100%	93%
No	8%	9%	-	7%

48. Is the Date, Time group information displayed in an acceptable location?

	AOAC	ANCOC	BNCOC	ALL
Yes	100%	100%	100%	100%
No	-	-	-	-

49. How useful would a time function be that allowed you to monitor progress of operations with respect to backward planning? (Exp: H-90, H, H+24)

	AOAC	ANCOC	BNCOC	ALL
Very Useful	33%	45%	80%	47%
Useful	42%	64%	-	32%
Not Useful	25%	18%	20%	21%

50. Is there any additional information you would like to have displayed in the Date, Time, area? Please specify below. [SEE REPORT]

Input Devices

This BMS prototype used a trackball for positioning the cursor and a mouse for triggering data inputs.

51. In general, were these input devices easy to use?

		AOAC	ANCOC	BNCOC	ALL
Mouse	Yes	58%	80%	80%	71%
	No	42%	20%	20%	29%
Trackball	Yes	25%	55%	83%	48%
	No	75%	45%	17%	52%

52. Was the trackball control accurate enough for the following functions?

		AOAC	ANCOC	BNCOC	ALL
Selecting Menus	Yes	58%	82%	67%	69%
	No	42%	18%	33%	31%
Drawing	Yes	25%	27%	33%	28%
	No	75%	73%	67%	72%
Locating Objects	Yes	50%	82%	67%	66%
on the Map	No	50%	18%	33%	34%

53. Would you prefer that the mouse and trackball controls be configured as a separate control unit as they were for this demo or that they be mounted on the side of the BMS device?

	AOAC	ANCOC	BNCOC	ALL
Separate Unit	8%	-	17%	7%
Mounted Unit	92%	100%	83%	93%

54. Prioritize your preferences for the following input devices for developing your graphics and overlays on the BMS display. Rank from 1-4.

	AOAC	ANCOC	BNCOC	ALL
Touch sensitive screen	1	1	1	1
Light pen	2	2	2	2
Trackball/mouse mounted to BMS	3	3	3	3
Trackball/mouse separate control	4	4	4	4

Radio

The radio display was designed to provide an automated means for determining and pre-setting both the primary and anti-jam frequencies.

55. How useful is the capability for automatically determining your radio frequencies?

	AOAC	ANCOC	BNCOC	ALL
Very Useful	91%	82%	50%	79%
Useful	-	9%	50%	14%
Not Useful	9%	9%	-	7%

56. Is the display layout for preselected frequencies clear and easy to interpret?

	AOAC	ANCOC	BNCOC	ALL
Yes	91%	100%	100%	96%
No	9%	-	-	4%

The radio functions also provide automated selection of the receiving net or channel when a new net or channel has been selected on your R/T.

57. How useful is this automated selection of a receiving channel useful, provided the user can override the system when desired?

	AOAC	ANCOC	BNCOC	ALL
Very Useful	91%	82%	83%	86%
Useful	-	18%	17%	11%
Not Useful	9%	-	-	3%

58. In general, what net would you want selected for receiving given the following selections for transmit/receive? [SEE REPORT]

Black and White

59. When using these BMS maps on your display, how important are the following map features? Please rank these features from 1-10 with 1 indicating most important feature and 10, least important. (Assume Shading) [Features are reordered by importance ratings across entire sample, rather than by their original order on questionnaire.]

	AOAC	ANCOC	BNCOC	ALL
contour lines	1	2	1	1
roads	2	1	2	2
vegetation	3	3	3	3
towns	4	4	4.5	4
water	5	5	6	5
borders	6	6	4.5	6
churches	10	7	7.5	7
power lines	7.5	8.5	9	8
names of towns, roads, etc.	7.5	8.5	10	9
towers	9	10	7.5	10

60. What changes or improvements would you recommend for the cultural features provided by BMS if only black and white is available? Write in your recommendations for each of the following: [SEE REPORT]

61. When you "initialize" or bring up the map display for the first time, which of the following cultural features do you think should be automatically provided when only black and white is available. Please check only those features you want automatically provided.
[*s indicate those features selected by a majority of respondents in that group.]

	AOAC	ANCOC	BNCOC	ALL
roads	*	*	*	*
vegetation	*	*	*	*
towns	*	*	*	*
water	*			
contour lines	*	*	*	*

[Features not selected by a majority of respondents are: borders, power lines, churches, towers, names of towns, roads, etc.]

62. If you had to choose between a black and white display that could be moved around the tank or a color display that was locked to a fixed position, which would you prefer?

	AOAC	ANCOC	BNCOC	ALL
Fixed Color	55%	82%	67%	69%
Movable B/W	45%	18%	33%	31%

63. In what location do you think the BMS display would be most effective when you are in the following positions: [SEE REPORT]

APPENDIX B
PROTOCOL RECORD OF USERS' COMMENTS

INTRODUCTION

This protocol section is a record of all users' comments and recommendations expressed during their individual sessions while working with the BMS prototype displays and controls. These responses were recorded to ensure that any unanticipated insights or problems emerging from the users actual experience with the prototype's features and functions were captured. In addition, the protocol record was maintained (1) to avoid forcing users into incomplete or inaccurate specification due to question wording on the structured questionnaire (see Appendix A).

The protocol record submitted is basically a verbatim transcript of the users responses as expressed. Rewording was limited to (1) summations across users when more than one respondent provided the same recommendation and (2) provision of referents assumed, therefore not spoken, by the users working with and pointing directly to the various display and control features (see Figures 1-4).

The record also provides an index of frequency and source for each of the comments entailed. The ALL column refers to the total sample combined across all subgroups (AOAC, ANCOC, BNCOC) and frequency data, the number of subjects making this comment, is provided in the same column. Remaining columns in the protocol record reflect similar comments expressed by the Joint Working Group (JWG) of DCD; and the OTHER column includes similar recommendations by SMEs in Land Battle Test Bed area or experienced with related BMS technologies.

This protocol record is organized around the main BMS display areas and controls tested and this sequence corresponds to the order in which they were evaluated by each user.

	ALL	JWG	OTHER
MAP			
A. Terrain Features.			
1. Include railroads.	4	*	
2. Include water.	19	*	
A. Further differentiate swamps/marsh area.	3		
3. Shade in vegetation yet still be able to see contour lines and grids in wooded areas.	21	*	
4. Include quaries and depressions.	6		
5. In color display show border with thicker line.	4		
6. Include churches with towns.	4		
7. Include fuel resources like gas stations/ POL dumps.	1		
8. Relocate gridline button to menu of map features.	4	*	
9. Put zoom and scroll function on same menu page.	1		
10. As additional feature show terrain at as oblique view (3D).	3		
11. Color for roads is too bright and over-powers contour lines.	1		
12. Shade in towns in solid color.	17	*	
13. Be able to revolve map to orient it to direction you are moving.			*
14. Concerned over how many 1 over world scale grid sheets along with 1:50,000 and 1:25,000 representation of those grid sheets, computer could hold on one tape before you had to insert another tape.	1		
15. Use a paper map format with white background, brown contours.	13		
16. Be able to dim/brighten colors or shades of a color so overlay graphics like ob-stacles does not blend in with vegetation.	5		*

	ALL	JWG	OTHER
17. Use other color than red to show towns--enemy is in red.	4		
18. Have BMS assist tank commander (TC) in terrain analysis-show key terrain obstacles (NO GO, SLO GO, GO).	1		
19. Include bridges and their classifications.	2	*	
20. Have display alert you when you reach a 1:50,000 and 1:25,000 map scale in display window as you zoom in.	1	*	
21. Include more roads (i.e. red balls, candy, stripes, white balls, trails).	13	*	
22. Ensure BMS has capability that as you zoom in from a 1 over world area when you reach a 1:50,000 area more detail (as on a 1:50,000 paper map) would automatically appear on display and if you further zoomed in to a 1:25,000 area more detail would appear on your terrain display (as shown on 1:25,000 paper map).	17	*	*
23. Include keys for "names of towns", "key terrain", "roads, etc."	1	*	
24. Power lines not needed.	1		
25. Include contour numbers for elevation.	3	*	
26. Include rice paddies (Korea).	1		
27. Be able to display road numbers.	1	*	
28. Use other symbol for churches than + which can be confused for target reference points(TRP'S).	3		
29. Show symbol for paved lanes as they are on a paper map.	1	*	
30. Include as menu items the names of water features.	1	*	
31. Include airfields.	1		
32. Include gas pipelines.	1		
33. Change blue color of border to another color so as not to confuse with water.	2		

	ALL	JWG	OTHER
34. Relocate "grid" button to culture item mem.	2	*	
35. Include regional features dependent on what region you are in (i.e. Korea-rice paddies, river fords, FRG-vineyards, PMT-depressions).	1		
36. Have menu showing various map scale buttons so you can quickly go to an area and get 1:250,000, 1:50,000, or 1:25,000 view at it.	1	*	*
37. Incorporate option to allow TC's to change certain colors due to red/green color blindness, or working under red light conditions (or give optional colors).			*
38. Must have ability to easily overlay (draw or type) scaled paper overlays onto digital map. and they require similiar digital map scaling and detail.			*
39. Declutter feature to selectively overlay grids culture features and graphic overlays required.		*	*
40. Map display window needs to be a size so that at: 1:250,000 scale you have 30 x 30 KMS 1:50,000 scale you have 6 x 6 KMS 1:25,000 scale you have 3 x 3 KMS		*	
41. Be able to differentiate height or stories of buildings and whether they have basements.			
42. As a minimum the computer needs to have stored five map sheets with the center map covering your area of operations.		*	

B. Free Draw or Select Funcitons

	ALL	JWG	OTHER
1. More responsive freedraw capability required, i.e. with touch sensitive screen, select ink color then draw, when finished, touch a finish button or have computer automatically stop draw function ten seconds from last item drawn. With map select ink and draw when button pressed; stop drawing when button released; begin again when button pressed.	17	*	
2. Incorporate a responsive eraser function to erase any overlay graphics but not remove terrain culture (i.e. have eraser button and when touched, you then go back and erase errors).	17	*	

	ALL	JWG	OTHER
3. Teach BMS computer friendly and threat units so if you put three tasks together on your terrain display it will display symbols or pictures to a military symbol for a Soviet PLT.	5	*	
4. Be able to shrink/enlarge symbols or pictures placed on map display (manually and/or automatically).	9	*	
5. More colors than blue, green and red need to be available for free draw.	1		
6. Free draw colors need to be more readable over culture (reostat function).	2	*	
7. If selecting from a menu, be able to select symbol color when putting item on terrain display (Threat-red, targets-blue, Obstacles-green/red).	1	*	
8. Incorporate a permanent joystick to scroll map with zoom button on top of joystick.	1		
9. More responsive add item from menu capability. Be able to select menu item and keep adding that item to terrain display without each time going back to the menu.		*	
10. Be able to select from menu different types of lines (i.e. solid, dotted, classed, and then free draw having that type line.		*	
11. Incorporate note pad or clip board to have ability to use free text or format non-standard reports.		*	
12. Ability to indicate direction enemy target is facing or moving on terrain display.		*	
13. Capability of system to maintain on terrain display and scale free drawing symbols on items and menu selected items as you zoom, pan, and scroll the map.		*	

C. Zoom, Pan, Scroll Functions

	ALL	JWG	OTHER
1. Grid numbers need to be placed along two flanks of map display window at all times when grids are overlayed on map.	16	*	*

	ALL	JWG	OTHER
2. Retitle scroll buttons like "N, W, E, S" or "map right, map left, map up, map down" or "view up, view down, view left, view right" to maintain orientation if map moves or view moves or symbols.	16		
3. Be able to move map with hand through touch sensitive screen.	1		
4. New continuous function (see map slowly move) for centering function to maintain orientation.	12		
5. Have continuous scroll function when button pressed, stop when button released.	12		
6. Have continuous zoom in at function.	12		
7. Combine zoom and scroll function onto one menu and instead of two permanent zoom/scroll buttons, just have one button.	1		
8. Cursor should move with item/feature being centered.	1		
9. Line of and time distance function is of great value. Must be able to perform this function in any map scale.	8		

REPORTS

	ALL	JWG	OTHER
1. Include logistic and personnel status reports (Y1, Y1A, Y2, Y2A, Y3, Y3A, R2, R3).	11	*	
2. Use common format for all reports (i.e. A-who, B-what, C-where,whom, D-activity).	1		
3. Be able to fill in report lines by actually writing in entry through a touch sensitive screen.	3		
4. An additional detail item to a SPOT REPORT is what you think the enemy might do.	1		
5. Place menu window on left hand side of display (student is left handed).	2		
6. Would like to see report summary first to free write in report entries.	4		

	ALL	JWG	OTHER
7. Prioritize all report line entries and display high priority lines first with send button. (abbreviated)	14		
8. Each report line or prompt needs to be more noticable.	2		
9. Likes the format for complete report where one does not have to pull out a manual to get format.	1		
10. Additional detail items for a SPOT or SITREP is type of threat velocity and elaborate more on my course of action.	1		
11. Redesign the report, menu entries for greater clarity and accuracy (e.g., reduce entries, more menu options, units of measure).	5	*	
12. Would like ability to erase terrain map display to use entire screen to format certain reports where terrain map not applicable; yet still have quick map return back.	4		
13. Reports take too long stepping through, too many menus to complete. On time constrained situations, digitized report must be done in less or equal time as it would be to do them with voice commo and scratch pad.	15	*	
14. On reports that have line entry for time, show along with keypad in menu a button labeled TIME NOW and when pressed would take DTG from top display window and stamp it in as line entry.	5		
15. Utilize a police code format for selection of report line entrys (e.g., "10-52 is request ambulance, etc.").	1		
16. Incorporate a printer at battalion headquarters for S1, S4, S2, S3, FSO, etc. and BMS identifies messages incoming by staff section they go to.	1	*	
17. Integrate map as part of reports.	18	*	
18. Fit report summaries onto one menu page.	1		
19. Include a scratch pad at end of all reports for remarks.	1		
20. File messages by time.	1		

	ALL	JWG	OTHER
21. Have BMS automatically time stamp each report when it is sent and input your call sign (when you press send button or if on auto when BMS sends it forward).	1		
22. Capability to send/receive reports in graphic, alphabetical/numerical or both--either manually, automatically or a combination.		*	
23. Include road march order.		*	
24. Ability to edit incoming reports as to what items on the report you want permanently displayed onto your digital map, what items you do not want displayed, what to dump and what to store.		*	
KEYS			
1. Problem to read key labels at about 24" away on 8" display, abbreviate key labels.	7		
2. Relabel "culture" button as "features".	1		
3. Relabel "UTM" button as "Grids".	12		
4. Need to have permanent escape button or function to quickly exist from any menu and either cancel that menu function or hold it.			*
5. Color code your permanent keys (i.e. Contact-red, NBC-yellow, Call For Fire-red, etc.			*
MESSAGES AND ALERTS			
1. In message/alert window when BMS receives report it shows SPOT C24, BMS automatically tells sender BMS message received and sender's display shows RECEIVED B66. When user press spot box it displays message with sender's terrain display (maybe at this point show on sender's display VIEW) and if satisfied with report user presses ACKNOWLEDGE button and sender's display shows ACKNOWLEDGE B66.		*	
2. Never confuse acknowledge for received message.	12		

	ALL	JWG	OTHER
3. Ensure audible alert over CVC has distinct tone not to confuse with NBC over pressure failure or chemical warning; and sound does not interfere, cut out or distort, voice communication. Make it a pleasant tone.	4		
4. Recommends display area to also display his tank fire control requirements (i.e. temperature, evaluation, humidity).	2		
5. Have light blin. at driver's station to alert for incoming messages.	1		
6. Indicate map level in this window area.	1		
7. Ability to let TC prioritize incoming messages by type report or unit (i.e. BN CDR can have spot reports as first priority or all reports from AG first priority) label priorities "Flash", "Flash Override", etc.	1		*

DATE/TIME

	ALL	JWG	OTHER
1. Include month into this window area.	3		
2. Ability for system to automatically reflect another time zone if you tell it what country (or state) you are in.	2		
3. Incorporate alarm clock function and TC's ability to input his desires (i.e. make sleep plus time events; time to sunrise, sunset, moon rise, etc.).	1	*	*
4. Distinguish time as either Alpha or Zulu.		*	
5. Capability to incorporate backward planning with time and alert function for events.		*	

INPUT DEVICES

	ALL	JWG	OTHER
1. Need a touch sensitive capability for touching keys and free draw capability.	13	*	
2. Prefer joystick over trackball, with mouse button on stick.	5		
3. Have ability to remotely scramble/destroy BMS on another vehicle if captured or abandoned.	2		

	ALL	JWG	OTHER
4. Have a voice actuated display.	1		
5. Have clear plastic shield you can quickly drop or close over display so bumping against it does not mess up touch sensitive display.	1		
6. Computer processing speed needs to be just as quick when screen is cluttered as when it is blank.	23		

RADIO

	ALL	JWG	OTHER
1. Function to preset radios is not necessary.	1		
2. Frequency numbers need to be larger to read more easily.	1		
3. Have BMS alert TC if a party on his receive/transmit net (R/T) is isolated due to radio problems or off the net.	2		
4. Incorporate CEOI into BMS so the computer will automatically set your R/T's, authentication call sign's, frequency, etc.	1		
5. If someone goes to anti-jam (A/J) have indicator or other party displays on that net if in A/J mode. Maybe using reverse video.	2		

BLACK and WHITE

	ALL	JWG	OTHER
1. Show border with thicker line.	6		
2. Include churches with towns.	2		
3. Shade in vegetation, yet still see contour lines and roads in wooded areas.	18		
4. Include water.	13		
5. Include fuel resources like gas stations, POL dumps.	1		
6. Relocate grid line button to be in menu of map feature items.	1		
7. Be able to distinguish overlay graphics from map culture features.	2		
8. Shade in towns.	13		

	ALL	JWG	OTHER
9. Must be able to differentiate between rivers, white ball roads and contours.	3		
10. Have reostat feature to dim/brighten cultural features and overlay graphics.	4		
11. Have display alert you as you zoom in, when you reach a 1:50,000 map scale area in terrain window and 1:25,000 area.	1		
12. Include more roads (redballs, candy, stripes, white balls, etc.).	3		
13. Try a black/white paper map with white background.	8		
14. Display power lines as they are on a paper map.	1		
15. Include names of water bodies.	1		
16. Display roads as dashed (---) lines.	1		

DISPLAY LOCATION

	ALL	JWG	OTHER
1. If TC fully in turret, locate display to right front of TC.	14		
2. If TC head out, locate display at right front (same as number one but with tilt function.	11		
3. If TC shoulders out, locate display same as number 2.	4		
4. Have fixed color display with tethered black/white display.	1		
5. If TC fully in turret, locate display to left of TC suspended on bracket with tilt function from turret ceiling.	3		
6. If TC head out, locate display same as number 5 with tilt.	3		
7. If TC shoulders out, locate display same as number 5 with tilt.	2		
8. If TC fully in turret, locate right of TC near TC over ride.	2		
9. If TC head out or shoulders out, locate to front of TC above range finder.	3		

	ALL	JWG	OTHER
10. If TC shoulders out locate at Commander's weapon station with tilt function.	10		
11. For M2/M3 mount display between radios for all TC positions.	2		
12. For M2/M3 mount display right side of TC above coax doors for all TC positions.	1		
13. For all 3 TC positions, locate display on mount from turret ceiling right side of TC position with tilt function.	1		
14. Place display on swing arm for M2 and M3 Bradley.	1		
15. If TC shoulders out, locate display left of TC on flex arm mounted to column support.	1		
16. Display needs to be easily referened from all three TC positions, and yet can be moved or folded out of the way.	2		*

GENERAL COMMENTS

	ALL	JWG	OTHER
1. Even though through evaluation you will find certain preferences by position (tailoring), still incorporate flexibility to allow individuals to tailor functions to themselves.		*	*

FIRE SUPPORT

	ALL	JWG	OTHER
1. By pushing "Call For Fire" button and touching map display have quick request for fire. Let BMS compute range, direction and location; show friendly element, time stamp, call-I.D. by integrating BMS into nav system, LRF, fire control system, CEOI, commo system.		*	
2. Display with computer can interfere with TACFIRE and FATDS.		*	

	ALL	JWG	OTHER
POSITION LOCATION			
1. Project on display realtime position location of your vehicle and other friendly elements of unit (i.e. for platoon leader his vehicle and his platoon vehicle; for company commander his vehicle, the executive officers and the platoon vehicle; for battalion commander his vehicle the S3's and all company vehicles.		*	
2. Project on display positions of known or estimated enemy locations.		*	
3. Capability to template threat forces, their order of battle and weapon systems.			
STATUS			
1. Capability for graphic and alphanumeric status of all classes of supply.		*	
2. Provide interface with the Standard Army Retail and Supply System (SARSS).		*	
3. For personnel: -alphanumeric status of personnel status. -interface with the Standard Installation Personnel Reporting System (SIDPERS). -ability for display and computer to read digital dogtag.		*	
4. For Maintenance: -manual and automatic input of vehicle maintain status to include all vehicle systems, (i.e. weapon, commo, fuel). -interface with Standard Army Maintenance System (SAMS). -automatically maintain logbook records or provide certain input.		*	
INTEROPERATIVE PARTS			
1. Ability to accept peripheral printer.	1	*	
2. Ability to accept typewriter key board or single hand key pad.		*	
3. Ability to accept peripheral training devices.		*	

	ALL	JWG	OTHER
4. Ability to interface with UCOFT and other training technologies.		*	
TRAINING			
1. Embedded systems operations guide (TM-10,-20,-30).		*	
2. Embedded systems diagnostic and troubleshooting.		*	
3. Embedded tutorials.		*	
4. Capability to conduct interactive scenarios.		*	
5. Embedded checklists and standard operating procedure.		*	